UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
09/092,158	06/05/98	MERCHANT S	MERCHANT3333

EXAMINER	
EATON,K	
ART UNIT	PAPER NUMBER
2823	

DATE MAILED: 09/04/01

MM91/0904

CHARLES W GAINES
HITT CHWANG & GAINES
225 UNIVERSITY PLAZA
275 WEST CAMPBELL ROAD
RICHARDSON TX 75080

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary	Application No.	Applicant(s)	
	09/092,158	MERCHANT ET AL.	
	Examiner	Art Unit	
	Kurt M. Eaton	2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *17 August 2001* .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,4-12 and 15-24* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,4-12 and 15-24* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

Application/Control Number: 09/092,158
Art Unit: 2823

DETAILED ACTION

1. Applicant's request for reconsideration of the finality of the rejection of the last Office action is persuasive and, therefore, the finality of that action is withdrawn.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

3. Claims 1, 5, 6, 12, 16, 17, and 24 are rejected under 35 U.S.C. 102(b) as being anticipated by Kim et al. (U.S. Patent No. 5,591,671).

In re claim 1, Kim et al. (herein referred to as Kim) shows in Figures 4A-4C, for example, a process for fabricating a contact in a semiconductor substrate (21) having a contact opening formed therein, including depositing by physical vapor deposition a barrier layer (26/27) in the contact opening and on at least a portion of the semiconductor substrate, wherein the depositing the barrier layer includes depositing a titanium layer (26) and depositing a titanium nitride layer (27) on the titanium layer; depositing a contact metal (28) on the barrier within the contact opening; removing a substantial portion of the contact metal and the barrier layer from the semiconductor substrate to form a contact plug within the contact opening; and subjecting the contact plug to a temperature sufficient to anneal the barrier layer {column 4, line 10 - column 6, line 30}.

In re claims 5 and 16, Kim shows wherein the depositing the contact metal includes depositing tungsten {column 4, line 10 - column 6, line 30}.

In re claims 6 and 17, Kim shows wherein the depositing includes depositing the tungsten by chemical vapor deposition {column 4, line 10 - column 6, line 30}.

In re claim 12, Kim shows in Figures 4A-4C, for example, a process for fabricating an integrated circuit including forming an active device on a semiconductor substrate (21); forming a contact opening in a dielectric (24) deposited on the active device, wherein the contact opening is in electrical contact with the active device; depositing by physical vapor deposition a barrier layer (26/27) in the contact opening and on at least a portion of the semiconductor substrate, wherein the depositing the barrier layer includes depositing a titanium layer (26) and depositing a titanium nitride layer (27) on the titanium layer; depositing a contact metal (28) on the barrier within the contact opening; removing a substantial portion of the contact metal and the barrier layer from the semiconductor substrate to form a contact plug within the contact opening; and subjecting the contact plug to a temperature sufficient to anneal the barrier layer {column 4, line 10 - column 6, line 30}.

In re claim 24, Kim shows in Figures 4A-4C, for example, a process for fabricating a contact in a semiconductor substrate (21) having a contact opening formed therein, including depositing a barrier layer (26/27) in the contact opening and on at least a portion of the semiconductor substrate, wherein the depositing the barrier layer includes depositing a titanium layer (26) and depositing a titanium nitride layer (27) on the titanium layer; depositing a contact metal (28) on the barrier within the contact opening; removing a substantial portion of the contact metal and the barrier layer from the semiconductor substrate to form a contact plug within the contact opening; and subjecting the contact plug to a temperature sufficient to anneal the barrier layer {column 4, line 10 - column 6, line 30}.

Claim Rejections - 35 USC § 103

4. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

5. Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kim.

In re claim 23, Kim substantially discloses the invention as claimed but fails to show wherein the active device includes forming an active device having a design width of about 0.25 microns or less.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the active devices of Kim such that they have a design width of about 0.25 microns or less since a semiconductor substrate containing active devices with a design width of about 0.25 microns or less would minimize the dimensions of the overall device and result in a fabrication process utilizing a higher packing fraction and more efficient use of the space on the substrate. Furthermore, the specification contains no disclosure of either the critical nature of the claimed dimensions or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen dimensions or upon another variable recited in a claim, the applicant must show that the particular dimensions are critical.

6. Claims 4, 8-10, 15, and 19-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim in view of applicants admitted prior art.

In re claims 4 and 15, Kim shows wherein the contact opening is formed in a dielectric (24) {see Figure 4A}.

Kim fails to show wherein the contact opening formed the dielectric has an aspect ratio ranging from about 3:1 to about 5:1.

Applicants admitted prior art teaches that it is well known that the semiconductor market demands for faster and more powerful integrated circuits have resulted in significant growth in the number of device per unit area (i.e., a higher packing fraction of active devices). Accordingly, this increased packing fraction means that interconnections for circuits are made to a minimization of dimensions. Accordingly, aspect ratios of contacts are now on the order of about 3:1 to as high as about 5:1 {page 1, line 16 - page 2, line 6}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the contact opening of Kim so as to have an aspect ratio of between about 3:1 and about 5:1 as in the applicants admitted prior art since, as evidenced by applicants admitted prior art, in order to provide a device that meets the markets stringent demands and a device with a contacts with aspect ratios between about 3:1 and about 5:1 have the capability to accommodate a higher packing fraction.

In re claims 8, 9, 19, and 20, Kim substantially discloses the invention as claimed but fails to show wherein the barrier layer has a thickness ranging from about 5 nm to about 20 nm within the contact opening and wherein a field thickness of the barrier layer outside of the contact opening has a thickness of about 75 nm or greater; nor wherein the thickness of the barrier layer within the contact opening is about 5% to about 20% of the field area thickness.

Applicants admitted prior art teaches that barrier layers deposited by PVD methods within contact openings having aspect ratios large enough to keep up with the market trends in dimensional minimization and packing density maximization may be formed such that the barrier layers may have a thickness ranging from about 5 nm to about 20 nm within the contact openings and a thickness of 75 nm or greater in field areas outside the contact openings and that, because of the irregular topography of the surface of the device, the PVD process deposits barrier layers within the contact

opening only 5% to 20% as thick as portions of barrier layers that are deposited in the field areas outside the contact openings {page 4, lines 1-18}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the barrier layer of Kim such that the barrier layer had a thickness ranging from about 5 nm to about 20 nm within the contact opening and wherein a field thickness of the barrier layer outside of the contact opening has a thickness of about 75 nm or greater, wherein the thickness of the barrier layer within the contact opening is about 5% to about 20% of the field area thickness because, as evidenced by applicants admitted prior art, a barrier layer with the aforementioned dimensions would provide a for functioning barrier layer within contact openings having aspect ratios large enough to keep up with the market trends in dimensional minimization and packing density maximization and the difference in barrier layer thickness within and outside contact openings is simply the manifestation of applying a PVD process to deposit a barrier layer within a high performance device capable of keeping up with the market trends in dimensional minimization and packing density maximization. Furthermore, the specification contains no disclosure of either the critical nature of the claimed dimensions or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen dimensions or upon another variable recited in a claim, the applicant must show that the particular dimensions are critical.

In re claims 10, and 21, Kim shows wherein removing a substantial portion includes removing the contact metal and the barrier layer from outside the contact opening {see Figure 4B}.

7. Claims 11 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kim in view of applicants admitted prior art as applied to claims 10 and 19 above, and further in view of Bothra.

In re claims 11 and 22, Kim shows wherein the removing the contact metal and the barrier layer includes removing the contact metal and the barrier layer by etching processes {column 4, line 10 - column 6, line 30}.

Kim in view of applicants admitted prior art does not show wherein the contact metal and the barrier layer are removed by chemical mechanical polishing processes.

Bothra shows, in an analogous art related to methods of making reliable interconnect via structures, in Figures 3-6, for example, removing substantial portion of a contact metal (140) and a barrier layer (130) from a semiconductor substrate (100) to form a contact plug within the contact opening wherein the contact metal and the barrier layer are removed by an etching process that includes CMP processes {column 5, line 6 - column 7, line 3}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to remove the contact metal and barrier layer of Kim in view of applicants admitted prior art using CMP processes since, as evidenced by Bothra, CMP processes are well known processes known in the art which are able to remove contact metals and barrier layers to form contact plugs and the selection of a known contact plug etching process on the basis of its suitability for the intended use involves only routine skill in the art.

8. Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kim in view of Koyama.

In re claim 18, Kim shows wherein the subjecting includes subjecting the contact plug to a thermal anneal process for a period ranging from 10 minutes to 60 minutes and a temperature of 550 °C.

Kim does not show wherein the subjecting includes subjecting the contact plug to a rapid thermal anneal process for a period ranging from about 5 seconds to about 60 seconds and a temperature ranging from about 600 °C to about 750 °C.

Koyama teaches, in an analogous art related to a process for fabricating interconnections of a semiconductor device based on PVD, that a barrier layer formed from a titanium layer and a titanium nitride layer formed over the titanium layer may be annealed using a rapid thermal anneal process for a period ranging from about 5 seconds to about 60 seconds and a temperature ranging from about 600 °C to about 750 °C {column 6, lines 3-45}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to perform the subjecting step of Kim as a rapid thermal anneal process according to Koyama since the rapid thermal process of Koyama would accomplish what the thermal process of Kim accomplishes and would further reduce the thermal budget of the device, thereby providing a more robust fabrication sequence.

Conclusion

9. Paper related to this application may be submitted directly to Art Unit 2823 by facsimile transmission. Papers should be faxed to Art Unit 2823 via the Art Unit 2823 Fax Center located in Crystal Plaza 4, room 4C23. The faxing of such papers must conform with the notice published in the Official Gazette, 1096 OG 30 (15 November 1989). The Art Unit 2823 Fax Center number is **(703) 308-7722** or **–7724**. The Art Unit 2823 Fax Center is to be used only for papers related to Art Unit 2823 applications.

Any inquiry concerning this communication of earlier communication from the examiner should be directed to **Kurt Eaton** at **(703) 305-0383** and between the hours of 8:00 AM to 4:00 PM (Eastern Standard Time) Monday through Friday or by e-mail via kurt.eaton@uspto.gov.

LONG PHAM
PRIMARY EXAMINER